

MEASUREMENTS & AUTOMATION BASICS**Course Code : 313330**

Programme Name/s : Automation and Robotics
Programme Code : AO
Semester : Third
Course Title : MEASUREMENTS & AUTOMATION BASICS
Course Code : 313330

I. RATIONALE

Engineering diploma holders in electronics and allied disciplines are expected to identify and use various measuring instruments in industrial applications. Measurement-based control has always been at the core of industrial automation. This course is designed to give overview of the basics of Industrial measurements and its subsequent requirement in automation

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:

Test various electronic parameters in automation systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the characteristics of measuring instrument.
- CO2 - Use relevant instrument to measure specified parameters.
- CO3 - Maintain signal conditioning and data acquisition systems.
- CO4 - Identify different components of automation system.
- CO5 - Identify different components of robotic system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | Total Marks | |
|-------------|----------------------------------|------|-------------------|--------------------------|----|----|-------|-------|---------|-------------------|--------|-----------|-----|------------------|-------|-----|-----|-------------|-----|-------------|-----|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | Based on LL & TL | | | | Based on SL | | | |
| | | | | CL | TL | LL | | | | | Total | Practical | | SLA | | | | | | | |
| | | | | | | | FA-TH | SA-TH | | | | Max | Min | FA-PR | SA-PR | Max | Min | Max | Min | | |
| 313330 | MEASUREMENTS & AUTOMATION BASICS | MAB | DSC | 4 | - | 4 | 2 | 10 | 5 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | 25# | 10 | 25 | 10 | 175 |

MEASUREMENTS & AUTOMATION BASICS**Course Code : 313330****Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| 1 | <p>TLO 1.1 Describe the concept of measuring instrument and their types.</p> <p>TLO 1.2 Determine static and dynamic characteristics of measuring instruments.</p> <p>TLO 1.3 Identify standards of measurements.</p> <p>TLO 1.4 Identify errors in industrial measurement.</p> | <p>Unit - I Fundamentals of Electrical and Electronics Measurements</p> <p>1.1 Fundamentals of measuring instrument</p> <p>1.2 Types of measuring instruments: Analog, digital, electrical and electronics</p> <p>1.3 Compare analog and digital instruments</p> <p>1.4 Static and dynamic characteristics of instruments</p> <p>1.5 Calibration(need and methods:direct,indirect)standards of Instrument</p> <p>1.6 Errors in measurement, types of errors, sources of errors</p> | Lecture Using Chalk-Board Presentations |
| 2 | <p>TLO 2.1 Describe the procedure to measure displacement in automation system.</p> <p>TLO 2.2 Describe the use of rotary encoder to measure angle of given rotating device.</p> <p>TLO 2.3 Describe the procedure to measure frequency, period, voltage using DSO.</p> <p>TLO 2.4 Explain the working of function generator and signal generator with block diagram.</p> | <p>Unit - II Measuring Devices and Instruments</p> <p>2.1 Angular and linear displacement using potentiometer</p> <p>2.2 Rotary encoder: Working principle, specifications, applications</p> <p>2.3 Digital multi meter: Working principle, specifications, applications</p> <p>2.4 DSO: Functional block diagram and uses of Digital Storage Oscilloscope</p> <p>2.5 Signal generator: Basic working principle</p> <p>2.6 Function generators: Functional block diagram and applications</p> | Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations |

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|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| 3 | TLO 3.1 Explain the need of signal conditioning in the measurement. TLO 3.2 Differentiate AC and DC signal conditioning circuits. TLO 3.3 Describe function of given block of DAS. TLO 3.4 Differentiate types of DAS system. | Unit - III Data Acquisition System 3.1 Signal conditioning: Need, types of signal conditioning (block diagram of AC and DC signal conditioners) 3.2 Filter, isolator, amplifier and converter as a signal conditioner (only function) 3.3 Data Acquisition Systems (DAS): Need, types (single channel, multi-channel and computer based) 3.4 Comparison of types of DAS 3.5 Data loggers: Concept and applications | Lecture Using Chalk-Board Presentations |
| 4 | TLO 4.1 Identify the need and benefits of industrial automation. TLO 4.2 List applications of automation system. TLO 4.3 Describe function of components of automation system. TLO 4.4 Identify different types of automation system. | Unit - IV Basics of Automation System 4.1 Need and benefits of automation system 4.2 Application areas: Process industries, building, robotics, railways, infrastructure development, aerospace, automobiles electrical distribution, medical, telecommunication etc. 4.3 Automation hierarchy: Basic components and function of each component 4.4 Types of automation system: Fixed, programmable, flexible machine automation, process automation, factory automation 4.5 Different systems used in industrial automation: PLC, HMI, SCADA, DCS, drives | Lecture Using Chalk-Board Video Demonstrations Presentations |
| 5 | TLO 5.1 Describe the function of the given element of the robotic systems with the help of sketch. TLO 5.2 Explain with sketches the given degree of freedom for a robot. TLO 5.3 Compare given types of robot on the basis of degree of freedom, construction, end effector used and applications. | Unit - V Basics of Robotics in Automation System 5.1 Robotics: Block diagram and function of each component (sensors, drive system, control system, end effectors) 5.2 Construction and degrees of freedom of cylindrical robot 5.3 Construction and degrees of freedom of spherical and cartesian robots | Lecture Using Chalk-Board Presentations Video Demonstrations |

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------|----------------|--------------|
| LLO 1.1 Use multimeter to determine accuracy, resolution, precision for specified measured quantity. | 1 | *Measurement of accuracy, resolution and precision of given measuring device | 2 | CO1 |
| LLO 2.1 Calibrate given measuring instrument using direct method. LLO 2.2 Calibrate given measuring instrument using indirect method. | 2 | *Calibration of given measuring instruments by direct and indirect method | 2 | CO1 |
| LLO 3.1 Identify use of analog multimeter. | 3 | Measurement of AC voltage, current and resistance using analog multimeter | 2 | CO1 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 4.1 Identify use of digital multimeter. | 4 | *Measurement of DC voltage, current and resistance using digital multimeter | 2 | CO2 |
| LLO 5.1 Identify controls of function generator. | 5 | *Identification of front panel controls of function generator | 2 | CO2 |
| LLO 6.1 Use function generator to generate different types of waveforms (sine, square, triangular). LLO 6.2 Measure the frequency and amplitude of the waveform using DSO. | 6 | *Analysis of different waveforms using function generator and DSO | 2 | CO2 |
| LLO 7.1 Use DSO to measure amplitude and frequency of the given input signal. | 7 | *Measurement of amplitude and frequency of input signal using DSO | 2 | CO2 |
| LLO 8.1 Use potentiometer for linear displacement measurement. | 8 | *Measurement of linear displacement using potentiometer | 2 | CO2 |
| LLO 9.1 Use potentiometer for angular displacement measurement. | 9 | *Measurement of angular displacement using potentiometer | 2 | CO2 |
| LLO 10.1 Use of rotary encoder for angular displacement measurement. | 10 | Measurement of angular displacement using rotary encoder | 2 | CO2 |
| LLO 11.1 Verify concept of data acquisition system. | 11 | Verification of working of data acquisition system available in laboratory | 2 | CO3 |
| LLO 12.1 Verify filter as signal conditioner. | 12 | *Verification of filter as signal conditioning circuits | 2 | CO3 |
| LLO 13.1 Verify isolator as signal conditioner. | 13 | Verification of isolator as signal conditioning circuits | 2 | CO3 |
| LLO 14.1 Verify converter as signal conditioner. | 14 | Verification of function of converter (ADC/ DAC) as signal conditioning circuits | 2 | CO3 |
| LLO 15.1 Verify current to voltage conversion operation. | 15 | Verification of current to voltage converter as signal conditioner(4-20mA signal into 0-5 volt) | 2 | CO3 |
| LLO 16.1 Verify voltage to current conversion operation. | 16 | Verification of use of voltage to current converter as signal conditioner | 2 | CO3 |
| LLO 17.1 Identify components of automation system available in laboratory. LLO 17.2 Identify facilities of automation system available in laboratory. | 17 | *Identification of components and facilities of automation trainer kit available in laboratory | 2 | CO4 |
| LLO 18.1 Identify various PLC brands used in Industries. | 18 | *Identification of major industrial PLC available in market which are used for industrial process | 2 | CO4 |
| LLO 19.1 Inspection of Controls of PLC front panel. | 19 | *Identification of various parts of front panel of any 3 general purpose PLC | 2 | CO4 |
| LLO 20.1 Identify various input devices used in Industries. LLO 20.2 Identify various output devices used in Industries. | 20 | *Identification of various input and output devices used in PLC system available in laboratory | 2 | CO4 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|-----------------------|---------------------|
| LLO 21.1 Identify software and hardware of automation system using virtual lab. | 21 | Identification of hardware and software of PLC automation system with virtual lab | 2 | CO4 |
| LLO 22.1 Identify components of automation hierarchy. | 22 | *Identification of flow of automation hierarchy of automation system | 2 | CO4 |
| LLO 23.1 Inspect use of Human Machine Interface (HMI) in automation system. | 23 | Verification of use of HMI in automation system | 2 | CO4 |
| LLO 24.1 Identify components of robotics. | 24 | *Identification of function of major components of robotic available in laboratory | 4 | CO5 |
| LLO 25.1 Verify Degree of freedom of robotic system. | 25 | * Verification of number of Degree of freedom for robotic available in laboratory | 2 | CO5 |
| LLO 26.1 Measure various parameters (Amplitude, time, frequency). | 26 | Measurement of amplitude, frequency and time of a signal using simulation software | 2 | CO2 |
| LLO 27.1 Measure voltage resistance and current of a circuit. | 27 | Measurement of voltage, resistance and current of a circuit using simulation software | 2 | CO2 |
| LLO 28.1 Measure linear displacement using potentiometer using simulation software. | 28 | Measurement of linear displacement using potentiometer using simulation software | 2 | CO2 |
| LLO 29.1 Verify of function of data acquisition system using simulation software. | 29 | Verification of function of data acquisition system using simulation software | 2 | CO2 |
| Note : Out of above suggestive LLOs - <ul style="list-style-type: none"> • '*' Marked Practicals (LLOs) Are mandatory. • Minimum 80% of above list of lab experiment are to be performed. • Judicial mix of LLOs are to be performed to achieve desired outcomes. | | | | |

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Design practical model for measurement of linear or angular displacement using potentiometer and calculate its sensitivity.
- Build and test I to V converter circuit.
- Design and simulate any one signal conditioning circuit using open source simulating software.

Activity

- Prepare activity report on calibration, its need and procedure for a measuring instrument.
- Market survey of electronic measuring instruments used in laboratory.
- Prepare market survey report of major PLCs used in industry with their specifications.
- Prepare detailed informative chart of static and dynamic characteristics of measuring instrument.

Assignment

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- Identify all controls of a DSO available in laboratory and give its specifications as per data sheet.
- Prepare report on a Robotic system with the observations of industrial visit to any industry based on robotic system.
- Identification various automation systems available in day to day life and draw schematic of any system.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicious mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 1 | Digital multimeter 0-10A, 0-600V, 0-10 Mega ohm | 1,2,4,8,9,15,16 |
| 2 | Analog multimeter 0-10 A, 0-600 V, 0-10 Mega ohm | 1,3 |
| 3 | Portable data acquisition system: 8 bit ADC/channel 4 analog voltage inputs powered by USB. | 11 |
| 4 | Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button | 17,18,19,20,21,22,23 |
| 5 | IEC 1131-3 compatible PLC with programming Software and interfacing hardware, user manual, (complete PLC trainer system) with HMI | 17,18,19,20,22,23,21 |
| 6 | Robotic system: 6 DoF, 8Kg Payload, arm range:930 mm,max speed 10.5 mm/sec.with compatible software | 24,25 |
| 7 | Computer system installed with required simulation software. | 26,27,28,29 |
| 8 | Any open source or online simulation software. | 26,27,28,29 |
| 9 | Function generator: Frequency ranges 0.1Hz to 11Mz,Pulse and ramp, aspect ratio 95:5 | 5,6,7 |
| 10 | Digital storage oscilloscope :BW 60 MHz Dual channel | 6,7 |

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|-------|------|---------------------------------------------------------|-------------|----------------|---------|---------|---------|-------------|
| 1 | I | Fundamentals of Electrical and Electronics Measurements | CO1 | 8 | 2 | 2 | 4 | 8 |
| 2 | II | Measuring Devices and Instruments | CO2 | 13 | 4 | 6 | 6 | 16 |
| 3 | III | Data Acquisition System | CO3 | 14 | 4 | 4 | 8 | 16 |
| 4 | IV | Basics of Automation System | CO4 | 13 | 4 | 6 | 8 | 18 |
| 5 | V | Basics of Robotics in Automation System | CO5 | 12 | 2 | 4 | 6 | 12 |

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| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|--------------------|------|------------|-------------|----------------|-----------|-----------|-----------|-------------|
| Grand Total | | | | 60 | 16 | 22 | 32 | 70 |

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two offline unit tests are of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks. End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | | | Programme Specific Outcomes* (PSOs) | | |
|-----------------------|----------------------------------------------|-----------------------|---------------------------------------|------------------------|------------------------------------------------------------------------|-------------------------|-------------------------|-------------------------------------|-------|-------|
| | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| CO1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | | | |
| CO2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | | | |
| CO3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | | | |
| CO4 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | | | |
| CO5 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|-------|-----------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------|
| 1 | Jadhav, V. R. | Programmable Logic Controller | Khanna publishers, New Delhi, 2017, ISBN: 978-8174092281 |
| 2 | Madhuchhand A Mitra, Samarjit Sen Gupta | Programmable logic controllers and industrial automation an introduction | Penram international publication, New Delhi, 2015, ISBN: 978-8187972174 |
| 3 | Kalsi H.S. | Electronics Instrumentation | McGraw Hill, New Delhi, 2010, ISBN:978-0070702066 |

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| Sr.No | Author | Title | Publisher with ISBN Number |
|-------|--------------|------------------------------------------------------------|------------------------------------------------------------------------------------|
| 4 | Sawhney A.K. | Electrical and Electronic Measurements and Instrumentation | Dhanpat Rai and Sons, New Delhi, 2005, ISBN: 978-8177000160 |
| 5 | David A.Bell | Electronic Instrumentation and Measurements | Oxford University, Press New Delhi India 3rd Edition, 2013, ISBN-13 978-0195696141 |
| 6 | W.Boltan | Mechatronics | Pearson Education, ISBN 978-8131732533 |

XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|-------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1 | https://youtu.be/tN7iAzVEqa0?feature=shared | NPTEL lecture on measurement |
| 2 | https://youtu.be/fg9No42IjnM?feature=shared | How potentiometer works(linear and rotary type potentiometer) |
| 3 | https://youtu.be/tw-79FiRYKA?feature=shared | What is industrial automation |
| 4 | https://youtu.be/uOtdWHMKhnw?feature=shared | Programmable logic controller basics explained - automation engineering |
| 5 | https://youtu.be/E2WNPXJf-Kw?feature=shared | PLC Introduction, PLC basics, Components of PLC, modular PLC, Modules (input Output) |
| 6 | https://youtu.be/kujHQgK352o?feature=shared | What is HMI |
| 7 | https://youtu.be/uxKyLTMv9js?feature=shared | How to do measurements using digital storage oscilloscope (DSO) |

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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